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## APPROPRIATE DESIGN AND APPLIED TECHNOLOGIES FOR THE DEVELOPMENT OF HUMAN SETTLEMENTS INFRASTRUCTURES IN AFRICA

LC/NAIROBI

## Introduction

1. The provision of adequate shelter in decent human settlements is a major concern of governments of member States in Africa, and also engages the attention of many international and non-governmental organizations operating in the region. It is well recognized that the kind of human settlements needed to promote the well-being of residents and enable them to participate actively in the local and national social and economic life means more than the mere provision of housing units. Basic infrastructures such as water supply, electricity, sanitation facilities, roads and transport facilities, as well as other services like health and education are all necessary to ensure the completeness of life in human settlements. In fact, the Global Strategy for Shelter to the year 2000 adopted by the Commission on Human Settlements at its 11th Session in April 1988 stressed that the provision of water supply and sanitation services in adequate quantities will be a key input to the production and improvement of shelter.

2. In many countries of the region, water-borne and excreta related diseases such as cholera, bilharzia, diarrhoeal diseases, infectious hepatitis and typhoid fever, constitute the greatest health hazard, causing high mortality, widespread morbidity and extensive loss of vitality resulting in low productivity. The improvement of both water supply and sanitation services, coupled with personal and environmental health education, is essential for achieving better health conditions within human settlements. The current situation in the region however reveals the need to take urgent measures towards achieving improvement in all these areas. Rural areas and slums and squatter settlements in the urban areas are the worst affected in the provision of human settlements infrastructure and therefore deserve the greatest attention.

3. The cost of providing basic infrastructures for the majority of the population in African countries is enormous. And viewed against the background of the chronic economic problems faced by most member States, reliance on the use of conventional approaches to the provision of human settlements infrastructures would only lead to a perpetual widening of the gap between service demand and the supply. Efforts are continuing in some African countries as well as in other countries in the developing world to develop infrastructure technologies that are better suited to the local social, technical and economic conditions, thereby contributing to the improvement of infrastructure coverage in both the urban and rural areas.

4. The purpose of this document is to review some of the available technologies for infrastructure development with special reference to water supply and sanitation facilities, examining experiences emanating from their application and then outlining some criteria for the selection of appropriate design and construction technologies. Recommendations for action at the national, regional and international levels are proposed to stimulate renewed commitment and action towards an improvement in basic infrastructure provision in human settlements through the optimum utilization of available resources.

## Water supply

5. In 1983 about forty per cent of the population in Africa had access to safe drinking water, compared with the global (world) average of 52%. Predictably, the urban areas were better serviced than the rural areas. Almost 60% of the African urban population were served while in the rural areas, where over 70% of the total population live, only 30% of the inhabitants had access to safe drinking water. In a survey of community water supply needs in Africa conducted by ECA it was found that whereas 30 of the 41 countries surveyed provided water to over 50% of the urban population, only 5 had been able to achieve the same level of coverage in the rural areas 1/. The survey also revealed that while some countries had shown improvements in water supply coverage from 1970 to 1983, in others, the provision of water had not kept pace with population increases, resulting in a reduction in service coverage over the same period.

## Urban water supply

6. In the cities and large towns, centralized water supply systems constitute the main source of potable water with house connections being provided in most medium and high income zones. Yard taps and standpipes meet the water requirements of the bulk of the population in low-income settlements. Slums and squatter settlements are generally poorly served and this, added to the poor quality of sanitation facilities creates very unhealthy conditions in such settlements.

7. In a low-income housing project in Addis Ababa (Ethiopia), the water supply network was designed to supply every plot in the future, but initially only one public tap was built to serve 50 households. The cost per plot of the public tap was about $US 70.00 which was half the cost of providing private connections. As the incomes of the residents improve they could opt for private connections. In order to ensure recovery of the cost of investment as well as the water consumption cost, a practical system has been evolved whereby public fountains are fenced, opened 8 hours a day by a guard, and consumers pay a fee on the spot as they collect the water. The system has operated satisfactorily and vandalism has been minimal because of the locked fence. 2/

8. Reliability is an important desirable quality of water supply systems. In Africa however, reliability is often very much affected by lack of effective maintenance practices. Apart from causing fluctuations or failures in the supply system, poor maintenance is also known to be the cause of impurity in water and losses in the distribution systems in the metropolitan areas. It is estimated that 20-40% of water is lost in the distribution system because of leakages. Improved maintenance, renovation and replacement of critical elements in water supply installations are essential in order to minimize water losses.

9. In Seychelles, for example, PVC, asbestos-cement and galvanized steel pipes which perform very well in some environments, were found to be unsuitable. Studies showed that cement-mortar lined ductile iron pipes performed better and have therefore been chosen as standard, for both water supply and sewerage. At the same time the institution of a simple leak detection programme has also reduced unaccounted water from over 40% to about 20% of production. 3/

Rural water supply

10. The rural water problem translates into three important dimensions, namely: distance form water source, quantity and quality. In many settlements the water sources are far away and women and children spend several hours a day fetching enough water to meet the family's needs. A study of the impact of 8 self-help water supply schemes in Tanzania showed that the improvement which the villagers liked most was the reduced distance from the house to the water source. The second most frequently mentioned item was better quality, primarily in terms of taste and appearance. This improvement was due to a better water source being tapped rather than water treatment. The benefit of greater quantity of water available was hardly mentioned, and the actual amount of water carried home did not seem to have increased appreciably with the building of the new schemes. 4/ An important consideration in improved rural water supply should therefore be to bring the water close to the settlements.

11. The low cost and simplicity of handpumps have made this technology attractive to governments and international development agencies seeking maximum impact from limited financial resources in rural community water supply. In several African countries, for example, Burkina Faso, Ethiopia, Ghana, Kenya, Malawi, Tanzania and Zambia, rural water projects based on hand pumps have been implemented. A major problem has however, been that once the pumps are installed there tends to be very little maintenance with the result that between 30-80% of the handpumps installed in the African region are out of operation at any given time. Several factors have been identified as being responsible for this situation. These include the following:

i) Poor quality of design and manufacture;
ii) Use of a large variety of handpumps with the accompanying need for spare parts which may not be easily available within the country,
iii) Poor maintenance skills, lack of training, inadequate tools, and sometimes inadequate means of transport for maintenance teams.

12. In view of the great potential benefits from the widespread use of handpumps, the World Bank sponsored a five-year project in which an intensive study was undertaken of handpump performance in laboratory and field conditions. The study covered 17 countries in the developing world and involved 2,700 individual pumps of 70 different models. Based on the result of this study and on information collected from rural water supply projects throughout the developing world, the following guidelines were proposed for the design of pumps for rural application:

i) Ease of maintenance: The design should be such that the replacement of all wearing parts can be undertaken by a village caretaker after a minimum of training and with only a few basic tools;

ii) Robustness: Non-wearing parts should be robust and durable, able to resist vandalism, climatic conditions and corrosive or sand-laden water;

iii) Local manufacture: Design should facilitate local manufacture from widely available materials, thus also enhancing availability of spare parts;

iv) Standardization: The adoption of a limited number of pumps will facilitate the training of caretakers and mechanics, and promote establishment of local manufacturing, enforcement of quality control and supply of spare parts;

v) Costs: The pumps should be low in capital and recurrent costs;

vi) Discharge rates: The pump models should be designed for specific ranges of pumping lift, with discharge rates selected accordingly.

13. Table 1 gives a summary of the various options that are available for community water supply schemes. While the ultimate target should be to bring water within easy reach of everyone, preferably with connections to individual households, constraints of financial, physical and organizational resources make it impractical to achieve this goal in the African region by the turn of the century. Consideration of technological choice which open up opportunities to reach out increasing numbers of the population in both the urban and rural areas should continue to be paramount in the decisions of planners and engineers.

## Sanitation facilities

14. Comparatively, the provision of sanitation facilities particularly for human waste disposal in African countries is worse than it is for water supply. In 1983, only 29% of the total population had access to decent human waste disposal facilities. The situation in the urban areas was better than in the rural areas with 55% and 18%, respectively, being served with such facilities. There were, however, wide variations in service coverage

among the various countries. For example, while only 14(out of 41) countries reported adequate sanitation facilities for more than 50% of the urban population, only three countries (Mauritius, Libya and Tunisia) indicated 100% coverage. On the other hand 4 countries had less than 10% coverage. In the rural areas, as many as 18 countries had less than 10% coverage while only 5 countries reported a rural sanitation coverage of over 50%.

15. The present level of provision of other sanitation facilities including solid waste disposal and drainage, which all have very important consequences for health in human settlements, is also inadequate. The problem is more critical in the poor high-density sectors of cities and other large towns where shelter conditions are also generally deplorable.

## Sanitation technologies

16. Table 2 gives a descriptive comparison of sanitation (human waste disposal) technologies which would be appropriate under different prevailing conditions in the urban and rural areas. It covers such items as construction and operation cost, self-help potential, water requirement, appropriate soil conditions and institutional requirements for operation and maintenance. Socio-cultural factors also play an important role in the selection of sanitation technologies. Almost all the listed technologies are used in various African countries. The main characteristics of some of these technologies are described below together with an indication of the experiences associated with their usage.

## Pit latrine

17. Pit latrines are the most common human excreta disposal facility in developing countries, including Africa. The pit latrine consists essentially of three components, namely: a pit, a squatting plate and a superstructure. When the latrine is filled, the superstructure and squatting plate are removed, the pit is filled with soil and a new pit is dug. While it is low-cost and requires only semi-skilled and unskilled labour for its construction, the pit latrine has two main disadvantages: it usually smells and encourages the breeding of flies and mosquitoes. A potential hazard associated with pit latrines is the possible contamination of groundwater and thus disease transmission to users of well-water.

Ventilated improved pit (VIP) latrine

18. This is essentially a conventional pit latrine provided with a vent pipe which helps to overcome the deficiencies of bad smell and flies. The top of the vent pipe is covered with wire gauze to prevent the escape of house flies and mosquitoes which are inevitably bred. The pipe is also painted black and placed on the sunny side of the latrine to allow air inside it to heat up and create air circulation via the squatting plate opening.

Ventilated improved double pit (VIDP) latrine

19. In order to avoid the construction of another latrine once the pit is full, and to facilitate the emptying of the pit where space for a replacement latrine does not exist, a double pit latrine is used. The ventilated improved double pit(VIDP) as it is called, ensures that one pit is always available for use. When it gets full, it is sealed while the second is put into use. When the latter is almost full, the first pit is emptied and put back into use once more. In this way the two pits can be used almost indefinitely.

20. Ventilated improved latrines have become very popular for application in both urban and rural areas in several African countries, and are being widely used, for example, in Botswana, Ghana, Tanzania and Zimbabwe. In Ghana, the University of Science and Technology has developed a 10-seater version, called the K-VIP for communal use.

Reed odourless earth closet (ROEC)

21. The Reed Odourless Earth Closet is another improved pit latrine. It incorporates the use of a chute which channels excreta and urine into a chamber located at the rear of the superstructure. This overcomes the problem of the superstructure collapsing into the pit. The other advantage is that its contents can be emptied by removing the access cover at the rear of the superstructure. This system is common in Botswana and Tanzania where experience has shown that it is easily subject to fouling by excreta particularly during the cleaning of the chute. This has led to the development of a modified design in which the chute is eliminated, and the near end of the pit is extended just below the superstructure so that the excreta from the squatting slab can drop directly into the pit.

Aqua privies

22. The conventional aqua privy essentially consists of a squatting plate situated above a small septic tank that discharges its effluent to an adjacent soakaway. A drop pipe which is an integral part of the chute and

extends 10-15cm below the water level in the tank forms a simple water seal that prevents odour and flies in the toilet. Periodic desludging of the tank is necessary, usually when it is about two-thirds full. The system's efficiency depends on the maintenance of the water seal but experience from many countries shows that the seal is rarely maintained, except in cultures where the tradition of anal cleansing with water is prevalent, and this results in a high rate of intermittent malfunction. As a means of overcoming this problem, the self-topping or sullage aquaprivy was developed. The design provides for the addition of all household sullage to the tank, thus the water seal is readily maintained and the sullage is conveniently disposed of. In sewered aquaprivies, the use of soakaways is eliminated by discharging the effluent directly into sewers.

23. The different types of aquaprivies are used in a number of countries including Nigeria, Zambia, Zimbabwe, Botswana and Ethiopia. Apart from the common problem of failure to maintain the water seal cited above, other operational and maintenance problems have included, failure of soakaways due to impervious soil which is easily clogged with organic matter, blockages of vertical pipes discharging sullage into the tank (in self-topping aquaprivies), technical problems of ensuring that the tank is watertight and, the periodic emptying of the tanks has not always been well-programmed and undertaken.

Septic tanks

24. Septic tank systems are used in virtually all capital cities of the African region in low/medium density settlements. The conventional designs are intended for houses that have an in-house water supply and sufficient land for effluent disposal. The main problem with the use of septic tanks relates to desludging which is usually carried out by the municipal authorities. Overspilling of tanks to surrounding grounds is therefore not uncommon. The high cost of the system limits its use to relatively high income households.

Conventional sewerage systems

25. These provide the most convenient method, from the user point of view, for handling human excreta and household wastewater especially where the population exceeds 500,000. They are convenient, pose no risk to health when functioning properly, require minimal municipal maintenance and in general, operate with few service interruptions or emergencies. The systems are however, very expensive to construct, operate and maintain. They require a substantial amount of water and a water use of about 75 litres per capita is necessary to avoid blockages. The high cost of conventional sewerage systems have prevented large segments of the population, even in the cities where they are used, to benefit from the high level of service they provide.

A 70km sewerage network for Addis Ababa (Ethiopia) started in 1982 at a cost of about $US 12 million, would only serve just about a quarter of the city's population of nearly 1.5 million.

Shallow sewer systems

26. This is a recently developed sewerage system which holds promise for use in high-density low-income settlements where water-dependent human excreta disposal facilities are installed. Shallow sewerage eliminates the public health risks usually associated with inadequate excreta and waste-water disposal at relatively lower cost. A study of the total annual cost per household of various sanitation options found that shallow sewers were cheaper than even on-site sanitation systems at settlement densities in excess of 160 persons per hectare. 6/

27. Shallow sewer systems consist essentially of a network of small diameter pipes laid in shallow trenches away from heavy imposed loads, with small inspection chamers provided along their lenths to facilitate access for maintenance. Several houses are connected to the same sewer which when it emerges from the block, can be connected to a conventional street sewer, or discharged into a communal septic tank or discharged straight into ponds.

28. The system, which was first developed in Brazil and has been applied in squatter settlements and planned housing schemes in that country, has also been used successfully by the United Nations Centre for Human Settlements (Habitat) in a community development project in a spontaneous squatter settlement in Karachi, Pakistan. The shallow sewerage system requires a minimum average water consumption of at least 25 litres per capita per day for the sewers to operate without blockages. There is also no experience on which to assess its suitability in areas where bulky anal cleaning materials are used. There is no record of its use in an African country but it provides a technological option which can be considered alongside others, where favourable conditions exist.

Solid waste disposal

29. Another aspect of sanitation which requires attention concerns the disposal of solid wastes. This is more of a problem in urban areas than in rural areas where because the production of waste is low and there is plenty of land to assimilate dumped material, the need for a formal system of collection and disposal is minimal. In urban areas, there is the tendency for indiscriminate dumping of wastes - at street corners, in drainage ditches and river courses. In the low-income sectors of most urban areas, refuse collection points are located by the municipal authorities, who also organize the final collection and disposal from the dumps. Experience from several

cities shows that because of poor organization and inadequate vehicular support, the refuse very often decomposes at site, creating unpleasant odours and providing a suitable habitat for disease carriers such as rodents and flies.

30. The other common form of solid waste disposal which is used more in medium and high-incomes zones of urban areas, is the system where sanitary drums are placed at vantage locations for communal or individual use, and emptied periodically by municipal trucks for final disposal. An alternative system, practiced, for example in Addis Ababa, Ethiopia, depends entirely on the use of garbage trucks which serve specific locations. When the truck arrives, a horn is blown and residents carry their garbage directly to the truck for final disposal. Thus, no communal refuse dumps are used.

31. A recurring problem with these solid waste disposal systems is the perennial shortage of trucks to collect the waste for final disposal. Another deficiency observed in some cities is the limited number of final dump sites and their distance from the city which allows trucks to make only a few trips per day. Thus in many cities only about 50% of the garbage generated is collected.

32. The solid waste management systems in most cities and urban centres in Africa are unable to cope adequately with the rate of waste generation and therefore require improvement. It is important to review the current situation with respect to the technologies used as well as the managerial, institutional and financial support systems in order to identify deficiencies and define suitable technological options.

Drainage facilities

33. The importance of adequate drainage facilities in human settlements derives from the need to dispose of waste water from dwellings and also storm water, thereby avoiding the incidence of stagnant water with its attendant health hazards, and also flooding during the rainy season, which leads to loss of life and property. While the provision of drainage facilities in the cities and other urban areas is inadequate in many countries of the region, the slums and squatter settlements which are mostly unplanned, are worse off. These areas are usually the worst affected after heavy downpours of rain. The improvement of drainage has therefore featured prominently in sites and services and slum upgrading projects.

34. Poor maintainance of street drains in cities usually renders them ineffective for the purpose for which they were provided. Silted open drains, which continue to be targets of dumping of all kinds of refuse by pedestrians as well as from households in adjoining properties can be found in many cities around the region. The incidence of flooding reported in cities in the recent past, draws attention of planners, designers and decision makers

to the need to take a comprehensive look at existing storm drainage systems, with a view to adopting improved planning, design and construction technologies which will limit the adverse effects of heavy and continuous downpours of rain in the future.

35. Lack of adequate drainage facilities also affects the stability of buildings in settlements and in the rural areas underscouring of buildings caused by uncontrolled flow of both waste water from households and rain water is a prevalent occurence. The provision of a simple network of properly designed earth drains, maintained by the local communities, would not only help in protecting the foundations of earth buildings which are popular in rural areas, but would also help to improve the general sanitary conditions within settlements.

36. Lack of drainage facilities also leads to the rapid deterioration of roads, and in rural areas where unpaved roads are frequent, poor drainage is the single most important factor that affects the serviceability of roads. The provision of both parallel and cross drainage facilities, as well as their proper maintenance, is essential to improve road accessibility as well as transportation services in rural areas. Design concepts that promote the utilization of local building materials in the construction of drainage structures should be promoted.

Selection of appropriate design and construction technologies

37. In general, the selection of an appropriate technology is based on a combination of economic, technical and social criteria. Very often, for example with respect to water supply and sanitation services in a rural context, these considerations reduce to the question: What is the least expensive, technically feasible technology that the users will accept and would be able to maintain and that the local authority is institutionally capable of operating? Even for road infrastructure for which users may not make direct payments, the involvement of local communities in the construction and maintenance of sections of road passing through their settlements could still be critical for achieving maximum benefits from the investments made.

38. Past experiences from the design, construction and maintenance of human settlements infrastructures, provide a guide in the selection of appropriate technologies that would promote the optimum use of available resources for infrastructure development to enhance the quality of life in both urban and rural human settlements. Some of the important considerations in this selection are outlined below:

Stage construction

39. The design of infrastructure should provide for upgrading the level of service in accordance with increasing resource availability and service demand. For example, Tables 1 and 2 give various options for community water supply and sanitation technologies. Within these options there is the possibility for upgrading or replacing technologies with those providing a better level of service. Fig. 1 gives a schematic representation of potential sanitation sequences and improvements depending on the level of water service. An important consideration at any stage of improvement should not only be the mere availability of increased financial resources, but also the availability of the required human and organizational resources to sustain the new technology.

40. The concept of step-by-step improvement is also valid for other infrastructure like road networks. In this connection it is important to ensure that an adequate right-of-way is reserved in the physical plans to eliminate, for example, the payment of compensation for properties that might have to be demolished to make room for the expanded facilities.

Sustainability

41. A recurring experience in the provision of infrastructure in African countries is that due to poor scheduling and implementation of maintenance activities, many facilities soon fall into disrepair leading to wastage of scarce financial resources. Many factors contribute to the maintenance problem, including inadequate financial resources, unavailability of equipment and spare parts, and lack of suitably trained technical and managerial personnel. Experience has shown, for example, that one of the primary considerations in designing and building a rural water supply project is to keep the technology as simple as possible so that local operators will be able to operate and maintain the system for long periods of time in the absence of an engineer. Selected equipment should have a good record of performance under similar climatic and socio-economic conditions.

42. It is important therefore at the planning stage to assess the maintenance requirements and the availability of resources to sustain the different technological options. Anticipated problem areas should be provided for at the project design stage. For example, training of maintenance personnel should be programmed, if found to be crucial to the successful operation of the infrastructure. The possibility of community involvement in the operation and maintenance of the infrastructure should be investigated. Another problem area of sustainability relates to effective organizational structures to collect user charges and organize maintenance activities. This should also be given special attention in technological choice.

Maximum utilization of locally available resources

43. The dependence on imported inputs-equipment, labour and construction materials for infrastructure projects has not only been a strain on scarce foreign exchange resources, but has also promoted the adoption of technologies which have been expensive and difficult to sustain. Appropriate design and construction technologies should now focus more on maximizing the use of locally available resources. The benefits of this approach to technology selection are many and include the following:

i) reducing project costs through the use of less expensive materials whose better supply would also reduce idle time at work sites caused by shortages in conventional construction materials;

ii) developing capabilities of indigenous construction firms by providing opportunities to undertake projects based on simple construction techniques;

iii) providing employment opportunities for local labour whose skills could be developed on the job to be applied to more difficult tasks on future projects;

iv) building up a body of design concepts and principles which are responsive to the local technical, economic and labour situation, thus contributing to the attainment of self-reliance in the design and implementation of infrastructure projects;

v) encouraging local fabrication of equipment and tools which will help to improve spare parts supply from local sources thereby helping to minimize equipment-related maintenance problems.

Community participation

44. Community participation has assumed increasing importance particularly with regard to infrastructure provision in rural areas, as well as in slums and squatter settlements in the urban areas. The objective is to design the project so as to make use of financial, technical and organizational resources that are available in the local community for whom the infrastructures are being provided. Experience from countries in the region show that many successful sites and services projects and community water supply schemes have benefited greatly from the involvement of the local community in the conception, design, construction and maintenance of the facilities. This involvement has also been a vehicle for rapid dissemination and adoption of appropriate technologies.

45. Another benefit of local community participation in infrastructural projects is the lowering of construction cost through the provision of voluntary labour. In some rural water supply schemes in Tanzania, labour provided through self-help accounted for between 10 and 30% of the total construction cost. 4/

46. Technological choice should therefore give due cognizance to the potential for involving the local community, which means that the level of technology prescribed should be that which the community can master after the necessary in-situ training and demonstration. For this to succeed, there should be strong and functional community organizations. The project formulation should make provision for giving the necessary institutional support to strengthen and enhance the effectiveness of such organizations.

Cost

47. The construction and maintenance of infrastructures in human settlements using conventional technologies involve large capital outlays. For example, the capital costs of community water supply projects are estimated to be: $US 10 - 30 per capita for groundwater schemes based on handpumps; $US 30 - 60 per capita for standpipe supplies, and $US 60 - 110 for yardtap services 5/. The high cost of investment requirements would make it almost impossible for most African governments to provide basic infrastructures to the vast majority of the population. Technologies which would reduce the current high per capita cost of infrastructure provision should therefore be accorded priority in project design and construction.

48. In a water supply project started in 1985 to provide 290 protected water points to the 300,000 inhabitants of Epworth, a peri-urban settlement close to Harare(Zimbabwe), the residents were provided technical supervision to use locally manufactured hand-operated drilling rigs to tap underground water. Locally designed and manufactured pumps were then installed. Once completed, the 290 installations would deliver a total of over 600,000 litres of potable water per day at an installation cost of less than Z$4.00 (about $US2.00) per capita, which is really low-cost 7/.

49. In considering cost as a criterion for technology selection, the potential for financial contributions from the local community could be vital. The communal spirit is strong in the rural areas of many countries and examples abound of village and town development committees which have taken the initiative to mobilize capital from local contributions which are then matched by funds from central governments to provide much needed infrastructure like water supply, sanitation facilities and electric power supply.

50. The cost criterion should also be viewed in terms of the ability and willingness of consumers to pay for the services to be provided in the case of infrastructure for which user charges would be levied.

Recommendations for Action

51. The resources needed to provide human settlements infrastructures in both the urban and rural areas of Africa are enormous. The concern of governments to address the infrastructure problem is equally great. It is important therefore that available resources are used efficiently to reach the greater number of people. The selection and application of appropriate design and construction technologies is therefore of vital importance and should constitute a vital component of human settlements programmes in the region. The following actions are recommended for the attention of member States.

At the national level

i) Promote the utilization of appropriate technologies in locally funded projects as well as in externally supported infrastructure projects,

ii) Encourage the development of local capacities for the fabrication of equipment and tools needed in support of appropriate infrastructure technologies;

iii) Provide technical assistance to community groups to utilise low-cost technologies in infrastructure projects;

iv) Strengthen existing institutions or set up appropriate institutions to organize training at different levels,

v) Encourage research on the development of low-cost and appropriate infrastructure technologies and support their utilization, initially in pilot projects;

vi) Promote the inclusion of courses in appropriate infrastructure technologies in the curricula of professional educational institutions;

vii) Encourage professionals to adopt designs and construction technologies that emphasize the utilization of locally available resources,

viii) Review existing design and construction standards and specifications which could inhibit the acceptance of proven technologies that lead to lower costs in infrastructure provision;

ix) Provide opportunities for the training of local contractors in innovative low-cost technologies;

x) Provide adequate institutional and financial support for the maintenance of infrastructures to ensure maximum benefits from the utilization of appropriate technologies;

xi) Initiate and support education programmes that would promote improved health conditions, in conjunction with the provision of critical health-related infrastructures like water supply and sanitation;

xii) Organize country-wide dissemination of low-cost infrastructure technologies by giving wide publicity to projects in which they are utilized;

xiii) Establish a mechanism for the sharing of information and experiences with other countries in the region.

At the regional and international levels

52. Regional and international organizations have a role to play in assisting African countries in their programmes to increase the coverage of basic infrastructures with limited resources. Their resources, including finance and experience acquired in other third world countries must be used to support the efforts of the governments of African countries. Specifically their assistance would be required in the following areas:

i) Encourage the adoption of appropriate technologies in the design and construction of infrastructure projects for which external funding is provided, giving due consideration to the need to maximize the use of local resources;

ii) Support research and development on innovative and low-cost technologies;

iii) Assist in training technicians and professionals both locally and abroad;

iv) Assist in the development of design standards and specifications as well as relevant codes of practice in support of appropriate technologies;

v) Assist in setting up or strengthening existing local capacities for the manufacture of equipment and tools;

vi) Promote information exchange among African countries and also between them and countries outside the region.

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Table 1. Options for Community Water Supply

| Step | Type of Service | Water source | Quality protection | Water use LPCD[a] | Energy source | Operation and maintenance needs | Costs | General remarks |
|---|---|---|---|---|---|---|---|---|
| 5 | House Connections | Groundwater<br>Surface water<br>Spring | Good, no treatment<br>May need treatment<br>Good, no treatment | 100 to 150 | Gravity<br>Electric<br>Diesel | Well-trained operator; reliable fuel and chemical supplies; many spare parts; wastewater disposal | High capital and O&M costs, except for gravity schemes | Most desirable service level, but high resource needs |
| 4 | Yardtaps | Groundwater<br>Surface water<br>Spring | Good, no treatment<br>May need treatment<br>Good, no treatment | 50 to 100 | Gravity<br>Electric<br>Diesel | Well trained operator; reliable fuel and chemical supplies; many spare parts | High capital and O&M costs, except gravity schemes | Very good access to safe water; fuel and institutional support critical |
| 3 | Standpipes | Groundwater<br>Surface water<br>Spring | Good no treatment<br>May need treatment<br>Good, no treatment | 10 to 40 | Gravity<br>Electric<br>Diesel<br>Wind<br>Solar | Well trained operator; reliable fuel and chemical supplies; many spare parts | Moderate capital and O&M costs, except gravity schemes; collection time | Good access to safe water; cost competitive with handpumps at high pumping lifts |
| 2 | Handpumps | Groundwater | Good, no treatment | 10 to 40 | Manual | Trained repairer; few spare parts | Low capital and O&M costs; collection time | Good access to safe water; sustainable by villagers |
| 1 | Improved traditional sources (partially protected) | Groundwater<br>Surface water<br>Spring<br>Rainwater | Variable<br>Poor<br>Variable<br>Good, if protected | 10 to 40 | Manual | General upkeep | Very low capital and O&M costs; collection time | Improvement if traditional source was badly contaminated |
| 0 | Traditional sources (unprotected) | Surface water<br>Groundwater<br>Spring<br>Rainwater | Poor<br>Poor<br>Variable<br>Variable | 10 to 40 | Manual | General upkeep | Low O&M costs (buckets, etc); collection time | Starting point for supply improvements |

a/ LPCD - litres per capita per day
Source :S. Arlosoroff et.al :Community water supply - the handpump option. World Bank, 1987.

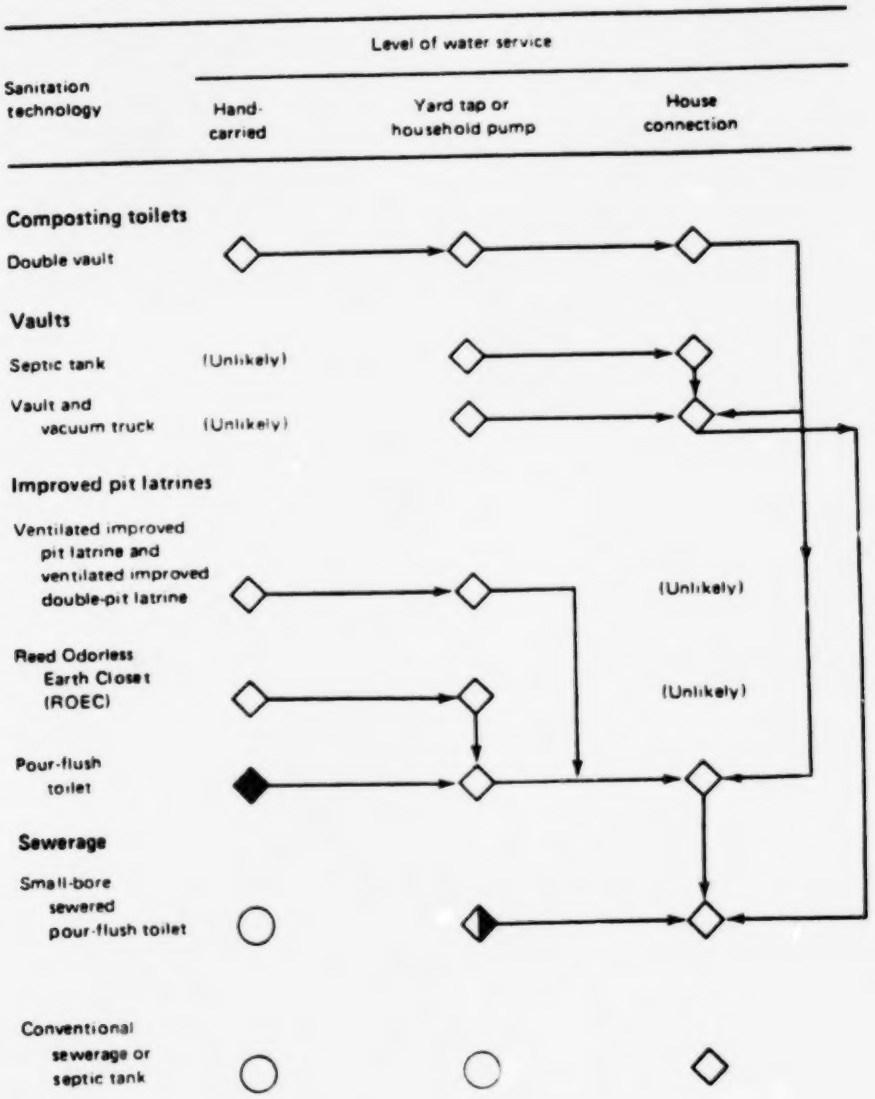
**Table 2 Descriptive comparison of sanitation technologies**

| *Sanitation technology* | *Rural application* | *Urban application* | *Construction cost* | *Operating cost* | *Ease of construction* | *Self-help potential* | *Water requirement* | *Required soil conditions* | *Complementary off-site treatment*[a] | *Reuse potential* | *Health benefits* | *Institutional requirements* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ventilated improved pit (VIP) latrines and Reed Odorless Earth Closets (ROECS) | Suitable | Suitable in L/M-density areas | L | L | Very easy except in wet or rocky ground | H | None | Stable permeable soil; groundwater at least 1 meter below surface[b] | None | L | Good | L |
| Pour-flush (PF) toilets | Suitable | Suitable in L/M-density areas | L | L | Easy | H | Water near toilet | Stable permeable soil; groundwater at least 1 meter below surface[b] | None | L | Very good | L |
| Double vault composting (DVC) toilets | Suitable | Suitable in L/M-density areas | M | L | Very easy except in wet or rocky ground | H | None | None (can be built above ground) | None | H | Good | L |
| Self-topping aquaprivy | Suitable | Suitable in L/M-density areas | M | L | Requires some skilled labor | H | Water near toilet | Permeable soil; groundwater at least 1 meter below surface[b] | Treatment facilities for sludge | M | Very good | L |
| Septic tank | Suitable for rural institutions | Suitable in L/M-density areas | H | H | Requires some skilled labor | L | Water piped to house and toilet | Permeable soil; groundwater at least 1 meter below surface[b] | Off-site treatment facilities for sludge | M | Very good | L |
| Three-stage septic tanks | Suitable | Suitable in L/M-density areas | M | L | Requires some skilled labor | H | Water near toilet | Permeable soil; ground water at least 1 meter below surface[b] | Treatment facilities for sludge | M | Very good | L |
| Vault toilets and cartage | Not suitable | Suitable | M | H | Requires some skilled labor | H (for vault construction) | Water near toilet | None (can be built above ground) | Treatment facilities for night soil | H | Very good | VH |
| Sewered P1 toilets, septic tanks, aquaprivies | Not suitable | Suitable | H | M | Requires skilled engineer/builder | L | Water piped to house and toilet | None | Sewers and treatment facilities | H | Very good | H |
| Sewerage | Not suitable | Suitable | VH | H | Requires skilled engineer/builder | L | Water piped to house and toilet | None | Sewers and treatment facilities | H | Very good | H |
| Shallow sewerage | Not suitable | Suitable | L | L | Requires skilled engineer builder | M | Water near toilet | None | Sewers and treatment facilities | H | Very good | M |

Source: J.M. Kalbermatten, and others, Appropriate Sanitation Alternatives: A Planning and Design Manual (Baltimore, Johns Hopkins University Press, 1982), p. 160 (modified to include shallow sewerage).

Notes: L, Low; M, medium; H, high; VH, very high
a. On- or off-site sullage disposal facilities are required for nonsewered technologies with water service levels in excess of 50 to 100 lcd, depending on population density.
b. If groundwater is less than 1 metre below the surface, a plinth can be built.

**Figure . 1 Potential Sanitation Sequences**




◇, Technically feasible. ◆, feasible if sufficient pour-flush water will be hand carried.
○, Technically infeasible. ◑, feasible if total wastewater flow exceeds 50 liters per capita daily.

Source :J.M. Kalbermatten et.al :Appropriate Technology for water supply and sanitation - A planner's guide (p.63) World Bank. 1980.

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# ROLE OF SMALL-SCALE BUILDING MATERIALS INDUSTRIES IN THE IMPLEMENTATION OF HUMAN SETTLEMENTS DEVELOPMENT PROGRAMMES AND RURAL DEVELOPMENT PROJECTS IN THE AFRICAN REGION

# I. INTRODUCTION

1. The key to successful human settlements development programmes in both the urban and rural areas is the construction of appropriate infrastructure especially decent and durable housing. In fact, a considerable portion of the investments goes into infrastructure. Therefore, what is crucial to such projects is the availability of good quality and cheap building materials. This is particularly relevant in the African region where there has been a sharp decline in building activity over the past few years because of the increasingly high costs of the materials used and the strain that they put on foreign exchange.

2. Indeed, in actual practice most of the countries of the region import the bulk of the materials that they use such as cement, iron, metal sheets and plaster. The use of imported materials became an acquired habit in both the formal sector such as government contracts and the informal sector, i.e., individuals building on their own account, during the period when the economic situation still allowed it. For example, the United Nations Industrial Development Organization (UNIDO) indicates that Egypt's cement imports increased from 700,000 tons in 1970 to 7.9 million tons in 1976.

3. For major construction such imports are justified by the standards demanded by the clients. Individual builders firmly believe that only imported materials can guarantee solid buildings.

4. It is obvious that due to the current indebtedness of African countries, builders who use imported materials are finding it increasingly difficult to maintain their level of activities.

5. In some countries the materials are locally produced in capital intensive factories which are understandably not many and which always require imported components such as machines, fuel and spare parts. This results in high costs that local investors find it difficult to bear. Whether materials are locally produced or imported, the problem is the same since factories are dependent on foreign exchange for maintenance purposes and for some of their inputs. Very often, the operation of factories are interrupted because of such problems and this results in periodic shortages which inconvenience their clients. Supplies are thus very unreliable and considerably hamper the development of the sector.

6. Moreover, the factories are often located near major urban centres and therefore cannot serve rural users who are scattered throughout the country; transport costs become prohibitive for the average individual in addition to possible logistical problems. Such factories can never contribute to rural development except in the case of special State-financed projects which are few in number because of their cost.

7. Yet, given the housing shortage facing the African region which is becoming worse as the years go by because of the very high population growth rate of 2.4 per cent, solutions must be found to this problem. However, before proposing any solutions, the characteristics of the building materials market need to be defined.

## II. THE BUILDING MATERIALS MARKET IN AFRICA

8. According to a UNIDO study, over the past decade, the consumption of building materials increased steadily in developing countries from $US 40.5 billion in 1975 to $US 75.5 billion in 1985. Such a trend is normal in view of the population explosion in developing countries. The study estimates that the proportion spent on the construction of housing is between 30 and 50 per cent depending on the countries. There are generally two types of building materials market, the formal market and the informal market.

### (a) Characteristics of the formal market

9. This sector comprises all government contracts which are the largest as well as private or semi-private clients who use contractors for building work. Such work covers mainly communal buildings such as schools, offices and hospitals and much less housing. Work is contracted out on the basis of invitations to tender which must include technical projects and contract documents.

10. The formal market has two characteristics:

Very restrictive standards that are often inherited from industrialized countries. Funding agencies always demand the application of such standards because of the 10-year guarantee required by regulations in force. Application of such standards has two very important consequences:

- costly building methods such as reinforced concrete are used;
- sophisticated materials such as cement or lime which are the only materials that can meet such standards are used.

11. Under current economic conditions, such materials are becoming increasingly expensive particularly in terms of foreign exchange. The result is increasingly high investment costs. Also for foreign exchange reasons, large production plants are finding it increasingly difficult to operate because they depend on imported inputs for their day-to-day maintenance; hence, supplies are erratic and there are occasional shortages which considerably hamper work and delay the development of such programmes. Moreover, projects are mainly concentrated in major urban centres, i.e., near large production plants. Indeed, because of problems of transport and logistics, such types of projects cannot be established in areas with very little urbanization. When such projects are implemented in rural areas contractors are often asked to produce their own materials. They often turn to local craftsmen who produce the basic materials such as bricks under their supervision. However, sophisticated materials such as cement, iron rods and corrugated sheets are still imported.

### (b) Individuals' attraction for imported materials

12. Often, the work of the formal sector is used as a model by individuals building on their own account who feel they must use the same materials, i.e., cement, concrete, galvanized sheets because they feel such materials guarantee quality. They do not want to use local materials such as tiles, lime produced by artisans, stones or wood. Yet, even if individuals can make financial sacrifices to purchase such materials, the strain on the country's balance of payments is unbearable.

13. In conclusion, it is obvious that current habits with respect to construction do not favour the development of human settlements particularly in the rural areas because the costs of the materials used are prohibitive and because it will become increasingly difficult to secure supplies because of the reasons mentioned above.

14. Governments should therefore take steps to promote the production of quality materials and encourage their use through construction programmes.

(b) Characteristics of the informal market

15. The informal market involves all those who build on their own account which is the case of the majority of the rural population. The price factor is crucial here and quality is completely incidental.

16. Seldom do people on this market buy supplies from large industrial plants. Builders have two possibilities:

- either producing the materials they require by using local raw materials such as clay to make burnt or adobe bricks, laterite for binders and thatch for roofing;

- or turn to craftsmen who work under roughly identical conditions, i.e., on the basis of techniques handed down from generation to generation.

17. The production of artisans has two major advantages:

- artisans set up wherever there are raw materials and therefore do not have any particular establishment constraints and can move around as they wish. This solves the transport problem since materials can be produced where they are used provided the raw materials are available which is often the case;

- cottage industries require very little investment and consequently costs are very much lower than costs of large production plants.

18. Unfortunately, it has several drawbacks which adversely affect the sector's development:

- Production quality is generally poor because of inappropriate methods of work. Quality is assessed using empirical rules (colour, sound and density) which are not tested in the laboratory. Moreover, since there are no serious studies on the nature of the raw materials used, the final quality of products produced by the same artisan varies very considerably. Of course, no particular standard is met;

- Inappropriate methods of work consume considerable energy. Since the usual source of energy is fire wood, it has an adverse impact on the environment;

- Often, production has no relationship to market demand: the volume of production over a given period of time is determined arbitrarily with the consequences that this might have on the quality of products.

19. As things stand now, using craftsmen is not a satisfactory option for human settlements development programmes in Africa where a minimum of quality is required in order to ensure that the constructions are durable.

## III. THE SMALL-SCALE BUILDING MATERIALS INDUSTRY IN AFRICA

### (i) Characteristics

20. By definition small-scale industry involves production units that require little investment to establish. This is a considerable advantage over the large production plants since any individual entrepreneur with limited resources can establish his own production unit. This means that many small production units can be established throughout a given country depending on potential demand and the availability of raw materials on the spot. Studies show that in the Africa region, raw materials such as clay, chalk, dolomite and vegetable fibres which are the bases for such an industry are generally abundant in all the countries. In any case, producers are brought closer to users which solves the problem of transport and at the same time reduces the prices of materials.

21. Because of their size, such units are easier to manage and it is a fact that large plants often fail because of management problems. Moreover, the operation of a small unit is much more flexible and it can tailor its production capacity to the requirements of the community without itscausing any financial risks to the entrepreneur.

22. For a long time, it was believed that materials such as cement could be profitable only if they were produced in large quanitities of tens of thousands of tons per year. Experiments have demonstrated on the contrary that units producing less than 20,000 tons have been profitable.

23. Small-scale industries use simple technology which has been developed by research centres specializing in building materials for developing countries.

24. First of all, such technologies use simple equipment such as brick presses or village kilnsthat are easy to maintain. The equipment can usually be manufactured locally and is generally cheap hence the little investment required to establish production units. There is therefore no problem of foreign exchange and the fact that the equipment is easy to maintain is a guarantee that it will operate regularly.

25. Secondly, such technologies use mainly raw materials that are available locally such as clay, chalk and vegetable fibres. In principle, such raw materials are abundant in the region and there is no problem of supplies.

The establishment of units depends not only on potential users but also on the availability of raw materials. This results in smaller production costs since the raw materials are generally cheap. Such technologies are tailored to the materials used and consequently yield products of good and consistent quality. This is definitly an advantage over traditional craftsmanship. Thus, small-scale industries are able to produce materials of satisfactory quality under the same conditions as traditional crafts industries, i.e., at low prices and in the areas where they are expected to be used and can thus play a very important role in reviving human settlements development programmes particularly in the rural areas.

(ii) Other advantages

26. Although small-scale industries require little investments to set up they use considerable manpower when compared to the larger plants producing the same output. It therefore generates jobs particularly in the rural areas; this is a very important aspect since employment is one of the crucial problems of developing countries. By creating jobs, small-scale industries increase the chances of success of human settlements particularly in rural areas. Special emphasis is put on the role of women since the tasks involved in the production of building materials are not incompatible with the employment of women.

27. It is worth noting that in spite of their simplicity, the technologies used in small-scale industries have been developed after serious research which took into account all aspects of the problem especially that of energy. Greater control of the production processes minimizes energy consumption. As fire wood is usually used as a source of energy, the introduction of such technologies helps to protect the environment. Whenever possible, other sources of energy such as agricultural (rice husks) and industrial (bagasse) waste products are used. This is a considerable advantage over traditional methods of production which consume a lot of energy and have many problems in securing supplies of fuel.

(iii) Current situation

28. Although locally produced building materials are not often liked by the public, many countries have started to experiment with such technologies.

Broadly speaking, there are three types of materials: materials for walls, binders and roofing materials.

(a) Materials for walls

29. Two types of materials seem to be suitable to the countries of the region: burnt clay bricks and stabilized earth blocks.

30. Burnt clay bricks are manufactured in almost all the countries either by large-scale plants or by small labour-intensive units. Small traditional production units predominate in the Central and East African subregions (Burundi, Kenya, Lesotho, Malawi, Madagascar, Rwanda, Somalia, United Republic of Tanzania, Uganda and Zaire) while in West Africa such bricks are mainly produced by medium-sized and large industries; the largest producer is Nigeria

which has a production capacity of over 100 million bricks a year.

31. Research has focused on improving the design of kilns in order to increase fuel efficiency. This not only helps to reduce costs but also to preserve Africa's forest heritage.

32. In some countries where the felling of trees endangers forest conservation, research has focused on alternative sources of energy for the baking of bricks. Various methods have thus been developed to use such sources of energy: peat in Burundi, mixing coal with clay in Nigeria and the United Republic of Tanzania, coffee husks in Uganda and palmnut husks in Ghana.

33. Studies are ongoing on the feasibility of using waste products such as rice husks, briquettes of wood shavings and nut husks.

34. It can be stated, therefore, that currently burnt clay bricks are the most widely used local materials in the region. However, efforts should be made to propagate its use particularly in West Africa and to improve the techniques used (more efficient kilns, other sources of energy and so on).

35. Stabilized earth bricks are a novelty in the region. They are still being used experimentally: construction of 300 housing units for a sugar company in Madagascar, programme for a thousand housing units in Uganda, a World Bank project for the construction of 86 primary schools in Senegal, a project for the construction of 90 housing units in Kenya (NHC) with USAID assistance.

36. The results of these experiments appear to show that the technology is well developed and could now be used commercially. Stabilized earth blocks have several advantages over burnt clay bricks:

- They do not require baking and this solves the problem of fuel which is crucial in the production of burnt clay bricks;

- They can be produced anywhere while clay is absolutely essential for burnt bricks hence the growing interest of builders in stabilized earth blocks.

37. However, both the properties of the soil and the optimal amount of stabilizing agent should be accurately determined. Lime or cement and sometimes chemicals developed by some specialized laboratories are used as stabilizer; this is why testing laboratories are needed. It should, however, be noted that considerable work has been done by research centres in this field and that even if there are currently no standards for stabilizing agents, recommendations and guidelines have been made and established in some countries such as Cote d'Ivoire and Togo.

38. The main item of production equipment is the press. Today, there are many manual or automatic models on the market. The equipment has been well developed and the most simple models can be constructed locally.

39. Today, therefore, there are no obstacles to the propagation of this building material; what is needed is simply to develop research on the amount of stabilizing agent required, depending on the soils used, and to establish appropriate standards on the utilization of stabilizing agents. Research should also be done on developing protective coatings because some experiments have showed that stabilized soil bricks are less resistent to weather changes than burnt clay bricks. Finally, publicity campaigns are essential to convince the public to accept stabilized soil bricks.

(b) Binders

40. Binders are materials that are used to join bricks or blocks in the building walls. Because cement is used throughout the entire region, some countries have come up with the idea of establishing small-scale cement production plants. Although experience has demonstrated that the idea is feasible, there are no plans to establish such plants everywhere because of technical constraints. The idea has therefore been mooted of developing other materials especially lime and pozzolana which can be found in large quantities in many areas.

41. Lime which was already used in construction in some countries has been literally ousted by cement; it is therefore little used today. Yet it has been demonstrated that where limestone and dolomite deposits are found the small-scale production of lime is perfectly possible. Lime can be used as a stabilizing agent in stabilized soil blocks, and particularly as a binder and lime wash.

42. Considerable research work has been done in specialized laboratories to determine the properties of limestone and to develop efficient burning methods such as vertical shaft kilns.

43. Small-scale production plants have been established in Madagascar and Togo by local entrepreneurs in collaboration with research centres. The results are very encouraging and should help to reintroduce lime into the construction industry as an alternative binder to portland cement.

44. Pozzolanas contain constituents which at ordinary temperatures will combine with lime and water to form compounds with cementitious properties.

45. Pozzolana may be natural (volcanic rock) or artificial. Artificial pozzolana may be made from inorganic compounds, i.e., calcinated rocks such as calcined clay, calcined bauxite or fly ash or from organic compounds such as the ashes obtained from the controlled burning of rice husk, coffee husk or groundnut husk or simply from bagasse.

46. Pozzolanas are still little used as binders in the region. They are considerably used in cement factories in Ethiopia, Cameroon, Rwanda and Burundi as supplements to obtain pozzolana cement.

47. Intensive research has been carried out by research centres throughout the world on lime and pozzolana mixtures but so far there has hardly been any practical application in the field. The results of the various studies show that the use of lime-pozzolana mixtures may save up to 40 per cent of cement for inferior quality concrete.

48. In the current situation, efforts can already be made to popularize the use of lime as a binder and research on developing pozzolana as a binder should be continued in order to use it in areas where there are abundant deposits of pozzolana.

(c) Roofing materials

49. Galvanized iron and corrugated asbestos sheets are the most widely used roofing materials in the region. Since they are imported products they are expensive and low-income earners cannot afford them. The public's passion for such materials stems from the fact that they are solid and modern. Even in the countries where local materials such as burnt clay tiles were used traditionally, iron sheets have now replaced them. Since then, a number of materials have been developed by research centres to replace iron and corrugated asbestos sheets.

50. First of all, burnt clay tiles deserve to be rehabilitated particularly in countries such as Madagascar and Rwanda where the technology for making them has already been mastered. The main disadvantage of burnt clay tiles is that they seldom last longer than 10 years. Efforts therefore be made to improve the production processes. As in the case of burnt clay bricks, the refinements developed by research centres should be used to improve the production of burnt clay tiles. The second materials on which research and experiments have been carried out is the asbestos cement tile. The fibers used to produce it are vegetable fibers, usually sisal. However, coconut fibers can also be used.

51. The results are very encouraging although the long term behaviour of these materials is not yet known. Production units have already been established in several countries including Kenya, Nigeria, Madagascar and Malawi.

52. The main item of production is the vibrating table because the quality of the product depends on the intensity of vibration. The tables may be electric powered - this raises the problem of energy in non-urban areas or they may be manually operated. However, the efficiency of manually operated tables has yet to be proved.

Summary

53. The materials presented here are not the only ones that currently exist; there are others such as stone, wood, thatch which are often used in the region. Those reviewed are the ones that can be produced by small-scale industries. The table below sums up their current state of development.

| Material | Research and development | Use | Acceptance |
|---|---|---|---|
| Lime | Ongoing | Experimental | Beginning |
| Pozzolana | " | - | Nil |
| Burnt clay bricks | Very advanced | Intensive (commercial) | Yes |
| Bitudobe blocks | Ongoing | Experimental and pre-commercial | Slight |
| Burnt clay tiles | Finished | Commercial | Average |
| Asbestos cement tiles | Ongoing | Experimental | ? |

(d) Regional co-operation

54. In view of the scope of the housing problem in the region and of the crucial role of materials in the development of building industries, many international bodies have looked into the problem with a view to promoting the production and utilization of local materials.

55. Particular mention should be made of the United Nations Centre for Human Settlements (Habitat) which is conducting projects on the development of small-scale local building materials industries in Africa in collaboration with the Commonwealth Science Council. Shelter Afrique, an intergovernmental low-cost housing financing institution is more concerned with the mechanisms for financing housing programmes; but on account of the impact of materials on such programmes, Shelter Afrique closely follows the development of local materials industries in the region. Finally, in 1987 ECA started a vast project aimed at promoting the production and use of local materials in the countries of the region. The strategy is based on attracting the interest of a large number of individual entrepreneurs in order to increase the number of production plants throughout African countries and on the acceptance by the public at large of the materials proposed.

56. To attract contractors to invest in this sector, the project envisages four types of action:

- Establishing prototype production centres which will serve as technical models. Such centres will be used to train contractors in the use of the technology and in management;

- Setting up demonstration buildings to initiate builders in the use of materials and at the same time show the public how useful it is to use local materials. Obviously, appropriate architectural studies will be carried out on the models in order to adapt them to the region and facilitate acceptance by the public;

- Carrying out a contractor's training campaign aimed at training contractors in the use of production technology and in the rediments of managing such plants;

- Encouraging and assisting governments to establish policies geared to promoting local building materials which would include establishing standards, using local materials in government building programmes and allocating resources for local building materials development.

57. A major publicity campaign will be launched to present the materials that can be locally produced to the public at large; all the media -exhibitions, television, radio, newspapers - will be used. The project, which is due to go into its implementation phase at the beginning of 1989, covers countries and will last approximately four years. It should lead to the popularization of local materials in the region and an increase in the number of production centres and yield all the expected consequences, i.e., revival of construction activities, better housing conditions, creation of jobs particularly in the rural areas and, finally, making the sector free of import-related constraints.

IV. CONCLUSION

58. In view of the problems that are facing human settlements and rural development programmes in the African region today, small-scale building materials industries might appear to be ways of reviving such programmes.

59. Small-scale building materials industries are capable of producing products that are of better quality than those produced by craftsmen at comparable prices. Because of the low investments required to set up such industries, it is expected that many of them can be established throughout a given country thus bringing producers closer to users and resulting in a considerable drop in the production costs of materials. As such industries use mainly raw materials that are available locally they are free from balance-of-payments contraints.

60. It should also be noted that the processes used minimize the consumption of energy and thus have a favourable impact on the ecological environment. Finally, small-scale industries are highly labour-intensive and their establishment will certainly have a favourable impact on employment especially in the rural areas.

61. However, as things stand now, these materials have not yet been accepted by the public. Consequently, considerable efforts have to be made to promote their use. Governments have a very important role to play by creating a favourable climate for the promotion of such materials, i.e., revising standards, establishing sources of financing and training programmes, providing support to research and development agencies and reflecting the needs of the sector in their development policies. Finally, governments should above all give an example by using such materials as a matter of priority in their projects. Experiences of some countries have demonstrated that the public is very sensitive to state action in this field.

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